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U.S. DEPARTMENT OF COMMERCE
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Public reporting burden for th existing data sources, gatherir estimate or any other aspect of this collection of [illegible] Institute of Standards and Technology, 100 Bureau Drive, Stop 4700, Administration Building, Room A332, Gaithersburg, Maryland 20899-4700. hours per response, including the time for reviewing instructio ns, searching wing the collection of information. Send comments regarding this burden ocing this burden, to Director, Advanced Technology Program, National

1. COMPETITION NUMBER	2. TECHNOLOGY AREA CODE	3. PROJECT DURATION
Competition 00-01	B0600 / I0400	3 (Three) YEARS 36 MONTHS

4.A. OTHER ATP SUBMISSIONS
LIST PROPOSAL NUMBER(S) OF SUBSTANTIALLY OVERLAPPING PROPOSAL(S) PREVIOUSLY SUBMITTED

NONE

4.B. IF SUBMITTING A CONCURRENT SUBSTANTIALLY OVERLAPPING PROPOSAL TO ANOTHER CURRENT OR PENDING ATP COMPETITION, LIST COMPETITION NUMBER(S)

NONE

5. LEGAL NAME, ADDRESS, AND WEBSITE OF SUBMITTING ORGANIZATION

Computer Aided Surgery, Inc.
300 East 33rd Street
Suite 4N
New York, New York 10016

http://www.casi.net

6. TYPE OF ORGANIZATION (CHECK ALL THAT APPLY)

- [X] PROFIT - SMALL BUSINESS
- [ ] PROFIT - LARGE BUSINESS
- [ ] PROFIT - MEDIUM BUSINESS
- [ ] FOREIGN-OWNED U.S. SUBSIDIARY

7. EMPLOYER IDENTIFICATION NUMBER (EIN)

E.I.N. #13-388-9180

8. DUN AND BRADSTREET NUMBER

D-U-N-S 94-285-4266

9. NAME OF PRINCIPAL INVESTIGATOR AT SUBMITTING ORGANIZATION
(Address required, if different than Item 5)

Dr.D. B. Karron (Ph.D.)
Chief Technical Officer
Computer Aided Surgery, Inc.

TELEPHONE NUMBER: +1 (212) 686 8748
FAX NUMBER: +1 (212) 448 0261
E-MAIL ADDRESS: karron@casi.net

10. NAME OF GRANT/CONTRACT MANAGER AT SUBMITTING ORGANIZATION
(Address required, if different than Item 5)

Dr. D. B. Karron
President
Computer Aided Surgery, Inc.

TELEPHONE NUMBER: +1 (212) 686 8748
FAX NUMBER: +1 (212) 448 0261
E-MAIL ADDRESS: karron@casi.net

11. SOURCES OF FUNDS	YEAR ONE	YEAR TWO	YEAR THREE	TOTAL
A. ATP (DIRECT COSTS ONLY)	$ 800,000	$ 600,000	$ 600,000	$ 2,000,000
B. PROPOSER	$ 30,000	$ 30,000	$ 40,000	$ 100,000
C. TOTAL (A + B)	$ 830,000	$ 630,000	$ 640,000	$ 2,100,000

12. PROPOSAL TITLE

Anatomic Computer Modeling for Precise and Accurate Therapies

13. NON-PROPRIETARY PROPOSAL ABSTRACT

Computer Aided Surgery, Inc. will develop a new computer application server that will take calibrated, encrypted raw images from a clients' medical imaging instrumentation (MRI, CT, Ultrasound, etc.), over the Internet. Our system will rapidly generate encrypted, precise, accurate, and variable resolution three dimensional tiled models applicable for diverse applications as radiation therapy, surgical planning, intraoperative guidance, rapid manufacturing of prosthesis, verification of surgical results, robotic surgery trajectory planning, patient communication, education and other customer specific applications

The novel idea, that enables the technological leap forward is Digital Morse Theory.

The essential insight of Digital Morse Theory is that it describes the behaviour of three dimensional SpiderWeb surfaces surfaces in terms of Morse Critical features.

These surfaces are the computational building tiles of the biologically and medically important objects we wish to parse from an opaque brick of bytes that compromise a volume data set.

We can build an index of all of the objects in a volume to utilize these elements in terms of their generator critical points: Our novel geometric construction algorithms will be embodied in a network based application service provider model. The server will upload from the radiological diagnostic image producer, and download to the therapeutic consumer model. We will function as a unique, super specialty medical imaging Internet Service Provider.

GOVERNMENT EXHIBIT
10A
07 Cr. 541 (RPP) (ID)

14. CERTIFICATION: BY SIGNING THIS PROPOSAL COVER SHEET, I CERTIFY, TO THE BEST OF MY KNOWLEDGE AND BELIEF, THAT ALL INFORMATION IN THIS PROPOSAL IS TRUE AND CORRECT AND THAT:

A. THIS PROPOSAL IS NOT REQUESTING FUNDING FOR EXISTING OR PLANNED RESEARCH PROGRAMS THAT WOULD BE CONDUCTED IN THE SAME TIME PERIOD IN THE ABSENCE OF FINANCIAL ASSISTANCE UNDER THE ATP.

B. ALL INDIRECT COSTS PROPOSED IN THIS PROPOSAL ARE INCLUDED UNDER THE PROPOSER'S COST SHARE AND NO INDIRECT COSTS ARE INCLUDED IN THE ATP SHARE OF COSTS REQUESTED.

C. IF A LARGE BUSINESS, COST SHARING PROPOSED BY THE LARGE BUSINESS IS AT LEAST 60 PERCENT OF EACH YEAR'S TOTAL COSTS.

D. THE TOTAL VALUE OF ANY IN-KIND CONTRIBUTIONS DOES NOT EXCEED 30 PERCENT OF THE COMPANY'S TOTAL COST SHARE.

E. THE FOLLOWING QUESTIONS HAVE BEEN TRUTHFULLY ANSWERED:

	YES	NO
I. IS THE COMPANY DELINQUENT ON ANY FEDERAL DEBT? (IF YES, EXPLAIN IN ITEM 15, REMARKS.)	☐	☒
II. WAS PROPOSAL OR VERY SIMILAR PROPOSAL SUBMITTED TO ANOTHER FEDERAL AGENCY? (IF YES, EXPLAIN IN ITEM 15, REMARKS.)	☐	☒
III. DOES THE COMPANY HAVE A PARENT COMPANY OUTSIDE THE UNITED STATES? (IF YES, IDENTIFY THE PARENT COMPANY AND ITS PLACE OF INCORPORATION IN ITEM 15, REMARKS.)	☐	☒
IV. IS THE COMPANY MAJORITY OWNED BY INDIVIDUALS WHO ARE NOT CITIZENS OF THE UNITED STATES? (IF YES, EXPLAIN IN ITEM 15, REMARKS.)	☐	☒
V. IS THE COMPANY SUBJECT TO CONTROL BY INDIVIDUALS WHO ARE NOT CITIZENS OF THE UNITED STATES? (IF YES, EXPLAIN IN ITEM 15, REMARKS.)	☐	☒
VI. DOES THE PROPOSED R&D INVOLVE THE USE OF HUMAN SUBJECTS AND/OR HUMAN TISSUE, AND/OR HUMAN CELL LINES? (IF YES, EXPLAIN IN ITEM 15, REMARKS, AND INDICATE WHETHER OR NOT THE RESEARCH PLAN HAS BEEN REVIEWED AND APPROVED BY AN INSTITUTIONAL REVIEW BOARD (IRB).)	☐	☒
VII. DOES THE PROPOSED R&D INVOLVE THE USE OF VERTEBRATE ANIMALS? (IF YES, EXPLAIN IN ITEM 15, REMARKS, AND INDICATE WHETHER OR NOT THE RESEARCH PLAN HAS BEEN REVIEWED AND APPROVED BY AN ANIMAL CARE AND USE COMMITTEE.)	☐	☒

15. REMARKS (CONTINUE ON A SEPARATE SHEET IF NECESSARY)

16. DESCRIBE WHAT EFFORTS WERE MADE, PRIOR TO APPLYING FOR ATP FUNDING, TO SECURE PRIVATE CAPITAL TO SUPPORT THIS PROJECT WHOLLY.

CASI's reputation as a basic research company has made our efforts to raise private capital for this high risk project difficult Traditional paths to commercialization financing would require many years of academic research, which private equity will not fund.

Our goal is to use ATP funding to go directly from preliminary results with a novel proven theory to market dominance intellectual property available to all medical and scientific customers over the internet.

17. AUTHORIZED COMPANY REPRESENTATIVE (TYPE NAME AND TITLE)

D. B. Karron, PhD President and CTO, Computer Aided Surgery, Inc.

18. TELEPHONE NUMBER

+1 (212) 686 8748

19. SIGNATURE

D. B. Karron PhD

D. B. Karron, Ph.D. President and C.T.O.

20. DATE

August 6, 2001

3 The National Opportunity

Computer Aided Surgery, Inc. (CASI) will build a new Application Service Provider (ASP) on the Internet for uploading stacks of pixel images from varied medical imaging producers and downloading to client PC's dimensionally accurate and precise 3D models. These models are for treatment planning, simulation, rehearsal, patient, and medical education. The key feature of the CASI service is that it produces a novel 'graph' or index into all of the volume objects and a 3D model, not just an image. The user manipulates the model on the client computer equipped with a 3D interactive graphics accelerator board, commonly used for computer games, via web browser plug-in software. The model is used for making critical treatment decisions, such as planning radiation beam trajectories. This is a surgical anatomic "blueprint" for treatment planning and evaluation, intended to model and demonstrate properties of patient data. Digital Morse Theory (DMT) permits rapid segmentation and converts pixels into contours enabling rapid interaction by users via the Internet.

CASI offers a unique opportunity for broad-based national benefits by improving the quality and standards of national medical care with reduced cost, patient mortality and morbidity with faster throughput in many application areas. In this proposal, CASI will target Radiation and Oncology with Radiation Treatment (RT) planning technology.

Current technology for anatomic modeling and treatment planning consumes time, labor, and is complicated to use. Currently, professional operators are producing varied results, even with the same data, reprocessed by the same operator. It is not suitably precise for critical radiation or surgical therapy. CASI's improvement will use its DMT 3D surface to rapidly obtain stable measurements delivered via web browser. CASI technology anticipates demands for trajectory planning in the emerging markets of surgical robotics, radiation treatment, and image-guided therapy. Support of these industries will reap broad societal benefits including better medical care, improved national worker productivity, and longer life.

3.1 Proposed Technological Solution

CASI will build a clinical geometry "foundry", casting clinical models in triangular tiles that define intricate, real surfaces in three dimensions. These models will be used for solving problems such as calculating trajectories for radiation beams to treat cancer. CASI's improvement will use 3D surface modeling to rapidly obtain stable measurements delivered via web browser. CASI will embody its novel geometric algorithm as a network ASP and will 'cast' anatomical structures for biological, surgical, and educational purposes. With novel mathematical theory, computer graphics programming experience, and clinical research experience, CASI will deliver in many high tech medical and non-medical modeling applications.

3.2 National Economic Benefits

The nation will benefit by improved health care that will prolong the quality of life. Reduced employee sick leave will decrease disability related payouts and reduce costs to insurers. The efficient use of medical information will produce better yield on capital in imaging technology. Better patient and physician communication, treatment results, and patient satisfaction will result in less litigation and insurance costs. It will also simplify clinical care. CASI will create new markets for model-based information as the core competency is established that will go beyond the initial applications. There are many potential markets. CASI is not selling a software product. It is providing a network-based service for manipulating user pixels into useful geometric constructs. CASI's business model is of software as an Application Service Provider (Torode 2001).

The visualization and modeling industry and technology are not being effectively developed in the United States. Wide diffusion of insight from image-based information will require new thinking, not just more bandwidth. CASI will move from a 'pixel based low information representation' to a

'DMT based object geometry representation' with high pragmatic information content.

Industries benefiting from this technology include medical imaging, animation, as well as Hollywood animation, and weather prediction in meteorology. The ultimate benefit to the public is better diagnosis and treatment for various cancers, with increased quality of life.

ATP funding is required because of short ROI period demanded by private investors, the relatively long development time required for this research, and the many broad areas beyond the immediately targeted medical application. CASI opportunities are in many disparate markets. The national opportunity is in the broad diffusion into many needed applications, and the ATP program is the only funding agency that can take such a broad view of the long term and fund it significantly.

3.2.1 Pathway to Economic Benefits

The CASI Internet solution will grow explosively once released. Internet payment systems provide the infrastructure for direct revenue recovery and interaction with customers. Insurance carriers reimburse costs of 3D studies at the one to three hundred dollar levels. Compared to the established market for high-resolution graphical representations in the medical illustration and advertising industry, it is clear that there is a much larger market for inexpensive patient specific diagnostic 3D models. CASI's intends to become THE clinical modeling resource firm, going beyond medical illustration, and becoming a reference standard for dimensionally precise and accurate anatomic models. The CASI will reduce the cost of generating models from tens of thousands of dollars and hundreds of person-hours to pennies and seconds.

The PI has extensive 'intrapeneurial' experience, starting with early computer networking within medical school in the early 80's (the ability to promote and launch projects inside large organizations). The PI has managed to attract bellwether early adopters in various medical specialties for early stage research collaboration. The PI's extensive medical center experience and professional standing enables CASI to effectively collaborate with clinical departments. These skills insure the broad diffusion of national benefits from CASI research into commercial development for the long-term success of the company and the return on the government's investment.

The PI has also recruited the participation of Mr. E. Gurfein, MBA, as the CASI project manager. Mr. Gurfein has over twenty years of experience in the marketing and commercialization of R&D with companies such as Sperry Rand, Perkin-Elmer, and Engelhard.

4 Potential for Broad-Based Economic Benefits

As discussed above, the broad based economic benefit to the nation will be improved health care that will prolong and improve the quality of life, reduce employee sick leave, will decrease disability related payouts, and reduce costs to insurers. The efficient use of medical information will produce better yield on capital in imaging technology. Better patient and physician communication, treatment results, and patient satisfaction will result in less litigation and insurance costs.

America is underutilizing the product of its diagnostic imaging capital base. The medical imaging industry is not making the best use of the mega pixels of patient data these systems generate. From an information theoretic perspective, CASI estimates that 99% of that information is not contributing to the making of therapeutic decisions. The diagnostic imaging industry is not disseminating this information to all concerned parties rapidly, effectively, and usefully. New picture archiving and network distribution systems are helping to manage the raw data, the Next Generation Internet can make more of the raw data move faster, but what our nation needs from this data is essential insight. CASI will increase the information content and the pragmatic value (Weinberger 2001) of medical pixels by winnowing them down to geometric models, trajectory vectors, and critical features/points. DMT solves significant practical problems in image understanding and 3D modeling, as well as information compression. This leads directly to improved diagnostic accuracy, and therapeutic precision. Analysis of medical images is expensive because of the extensive and expensive human photo interpretation, hand contouring, and guesswork that is the current practice.

Medicine needs a rapid 3D modeling capability for precision image guided therapies. This is a particular problem in medical image analysis. CASI addresses the hard problem of bringing advanced mathematical insight directly to various application markets, and improving the yield, efficiency, and cost effectiveness of image based diagnosis and therapies. For our primary example application, this is the critical measurement of accurate tumor border and surrounding anatomy geometry required for precise targeting for surgical and radiation therapy

4.1 Specific Broad Based Economic Benefit

Broad based economic benefits will result from the CASI development plan, which consists of the direct development of core technology into specialized application areas. CASI will accomplish further development by fostering a network of bellwether early adopters professionals in other areas, leading to indirect national economic benefits. CASI's leading application area is improved treatment of breast cancer, followed by the prostate.

The second greatest killer of Americans is cancer. Breast cancer continues to be the second leading cancer in women in the US, with more than 45K deaths this year (Greenlee *et al* 2001). Cancers of the prostate, colon, and rectum combined to contribute 45% of cancer deaths among men. As baby boomers mature and become more susceptible to cancers in the next 10 to 20 years, these rates are expect to increase at a rate much greater than the general population growth.

Improved treatment of breast cancer is CASI's primary application area, followed by prostate cancers

4.1.1 CASI application development areas

Radiation Treatment (RT) beam trajectory planning in collaboration with Sylvia Formenti MD, and Keith DeWyngaert PhD at New York University Medical Center will be CASI's first application area. RT is the preferred way to target many types of cancerous tumors; however, localization of therapeutic intensity without collateral damage to healthy tissue is a serious problem. Improved diagnosis and earlier treatment have produce significant reductions in mortality. CASI technology improves treatment and affects the reduction of the morbidity (symptoms) of the disease increasing the quality of life during and after treatment.

Early detection, improved surgical techniques, and aggressive systemic therapy have improved quality of life and survival for patients with less advanced breast cancer Tumor regression is the result of the targeted radiation.

The nature of prostate cancer, similar to the breast, is that more radiation produces a better cure. Better targeting technology will have a profound effect on morbidity and mortality.

However, the potential for RT of solid tumors has not been realized mainly due to the dose-limiting toxicity associated with systemic large levels of radioactivity. The technology to be developed will increase the radiation delivered precisely and accurately to the tumor site and decrease the dosage to the non-target regions, a significant improvement in the treatment outcome can be expected. Even greater improvement in treatment outcome is expected when targeting technology is coupled with a variety of methods under investigation at NYUMC to improve the tumor targeting of radioimmunoconjugates including the use of antibody fragments, recombinant single-chain antibodies, and drugs to modulate tumor vasculature. This technology will also be useful in other cancers including prostate, head and neck and colon.

Radiosurgery is the use of carefully targeted radiation instead of surgery to treat tumors, generally in the head and neck. This expensive high technology treatment can spare the patient from invasive dissection surgery, with low morbidity. Treatment planning is a vital and much larger part of these procedures, and CASI modeling technology is expected to play a significant part in reducing costs and increasing throughput (Karron 1992).

4.1.2 Specific National Economic Benefits Table

[1]Patient Population Class	New Cases in 2001	Cost Per Case in K$			Mortality, 000		Morbidity		National Cost B$ / Throughput		
		Hi	Low	Avg	Cur.	Del	Pre	Post	Now	Save	Rate
Breast Cancers	193,700	25	50	35	45	-2	Fair	Good	6.8	-.29	+25%
Prostate Cancers	198,100	30	20	25	30	-1	Fair	Good	4.9	-.27	+25%
Radiosurgically treated cancer	8,000	40	30	30	10	-1	VG	Exd	.24	.016	+50%
Estimated Totals	412,000			27.5			Fair	Good	12.2	-.59	+20%

The principal tangible value of the CASI technology treatment improvement is in reduction patient morbidity and cost, with an increased productivity. The estimated cost savings of CASI technology in RT planning is a reduction from $1K per average with a savings of $500 in cost savings for the Medical Physics component, a reduction from $2Kper case with a savings of $1K for the Physician Oncologist Treatment Planning, and a reduction estimated of $2K for Radiosurgery. RT treatment typically bills separately for the Medical Physics and the Oncologist treatment plans, so the savings are additive. Taking these cost savings to the national caseload will result in an estimated **national total savings of approximately $.5B / year, if CASI were in production today**[2]. Judging from the response to CASI collaboration offers by various medical specialty groups, there will be strong demand for our technology. **Assuming an average study produces at a $100 charge on the server computer, a 20% capture of the 400K/year new cases for RT treatment planning market, @ 2 studies / case, CASI can reasonably expect a gross revenue of $16M per year from this application alone**[3]. Finally, as explained above above, the national cancer rate is expect to grow faster than the national population growth, given the ageing of the baby boom cohort into middle and old age, where cancer strikes the most. Because CASI will become a web 'monopoly', it will become part of the standard of care for many RT and surgical procedures, CASI can expect much greater market share, as this market opens up and matures.

There are compelling intangible reasons for CASI technology beyond national cost savings and projected CASI revenue. Improved targeting means less total radiation dosage is used. That which is used is more concentrated, thus more effective in tumor shrinkage with less systemic toxicity, and less treatment morbidity (e.g., radiation damage to the heart, and/or lungs in breast cancer treatment, or the rectum and / or bladder in prostate treatment). Benefits for the patient are due to faster treatment planning, better targeting, with less treatment morbidity, and faster recovery.

Benefits to Insurance Companies and HMO's are better quality control; better ROI for imaging studies, and cheaper, faster, and better treatment planning. Insurance pays for 3D reconstruction studies, and RT planning, but at a price that does not permit adequate recovery of capital intensive computers they run on, and expensive software licenses, much less the time and expense of a professional to draft the studies. Typically, the studies cost so much more than insurance pays for them that they are not ordered, and are considered of marginal diagnostic value.

CASI can afford to charge as little as $100 per study, and is shown above, make significant revenue at a price third party payers reimburse. Depending on the application market, CASI or its franchisors, can charge more or less and still make money by the economics of scale, and the low cost and demands on its computer clients. CASI captures benefits from broad diffusion by charging for ASP time and usage, and as such directly benefits from broad diffusion via its bellwether and franchisor commercialization plan.

Application Area	Barrier	Solution
Dental Implant Surgical Planning	Optimal anchorage in inhomogeneous bone, optimal osseointegration	Braided DMT for optimal positioning
Hip Replacement, Finger Joint Replacement, and Orthopedic applications		
Earth Resources Imaging Analysis	Pixel Intensity (too many pixels)	DMT based image understanding
Hyperspectral Satellite Imaging		

[1] Data is from Greenlee et al 2001 CA Cancer Statistics 2001.
[2] Data is from typical NYUMC clinical collaborator billing.
[3] Estimated revenue linearly extrapolated from NYUMC clinical billing estimates and Cancer Statistics 2001 figures.

Application Area	Barrier	Solution
Meteorological Prediction	Isosurface modeling	DMT/SpiderWeb modeling
Craniofacial Surgery	Optimizing complex shapes	Braided DMT
Spine Surgery		
Medical Computer Graphics for Advertising, Medical and Patient Education	Expensive slow hand segmentation, excessive surface tiling, slow rendering, lack of interactivity	DMT based segmentation and surface relaxation
Medical Computer Animation for Hollywood Entertainment Applications		
Functional MRI analysis	High and Low resolution Image Fusion	DMT image fusion
Visible Human Embryo Project	Pixel Intensity (too many data pixels), Rapid Segmentation	DMT based segmentation and surface relaxation
Visible Human(s) project		
Fluid and Thermal Dynamics	Data complexity	DMT Graphing

5 National Economic Benefits

Business opportunities addressed by this proposal are the technology gap in precise and accurate surface modeling for critical surgical and radiation treatment planning, as well as many scientific applications. By using DMT technology for image and model compression, we will develop the research as an Internet based ASP. CASI will develop its core technology for applications in Radiation Treatment of Breast and Prostate cancer, as well as in neurosurgical planning.

End users and customers include any radiology practice, imaging facility, medical center, and associated individual practitioners. Patients will benefit the most from the interpretative method of CT, MRI, PET, SPECT, *etc* that currently use hand processed stacks of images in designing a treatment. Similarly, anyone attempting to spot critical surgical targets, such as in steriotactic brain surgery, by sighting by the center of blobby objects in hundreds of slices will be a customer. RT practitioners are most eager to find better methods to eliminate this drudgery, to more precisely locate tumors borders, and are project collaborators.

Competitors are scattered across various application area, using mainly volume rendering technology instead of shell surface technology. Most imaging companies are focused on one technology. Typically, these firms arise from image consulting firms working with one large customer with a specific application in petrology, histology, computer graphics, and so on. There are general-purpose visualization systems sponsored by government research labs (NCAR), and commercialization of large university programs such as ANALYZE (Mayo Clinic), 3DVIEWNIX (U. Penn). Commercial packages include Voxel View, AVS (Advanced Visualization System), Resolution3D, Khoros, Data Explorer DX (IBM) Iris Explorer, VTK tool kit (Kitware) are but a few of the more popular general packages. Some have exceptional interactivity based on their optimization to special graphics accelerator hardware, now common with the explosion of the computer game industry). Many have intricate and comprehensive facilities for hand segmentation, contouring, snake segmentation, thresholding, flood filling, edge detection, marching cubes, etc. None have the power and insight that Digital Morse Theory based segmentation can do to simplify many segmentation tasks. CASI will never manage to penetrate such a broad spread of markets, but expects that it will license its technology and that will become an important source of revenue and diffusion of our technology and theory into various industry sectors and broader national economy in ways that can barely be foreseen.

Competing RT planning software generally runs on Unix super workstations, based on a slice-by-slice hand drawn or computer assisted contouring. These installations are a department fixed resource. Packages fielded by RT hardware makers are tied to the vendors hardware. Independent RT software houses include Prism Microsystems, and RAHD Oncology planning products. Some sport names like Prowess Systems, for prostate brachytherapy (selling supplies and training through their web site) and Nomos Corporation specializes in Intensity Modulated Radiation Treatment (IMRT) with CORVUS Inverse Treatment Planning. The Radiation Physics departments, at the University of Florida, use and promote the Pinnacle3 Treatment Planning from spun out companies. Oak Ridge National Labs distributes software for RT using Visible Human Data. Most use volume visualization as an aid to review slice-by-slice layout results. None make use of 3D surface

technology because of problems with the technology that CASI solves.

None of these companies is able to directly offer their services via the Internet because of image compression issues and interactivity latency issues. All of these systems were developed before the Internet boom. It will be extremely difficult for them to reinvent themselves as competing ASP's due to the image understanding, modeling, and compression barriers that DMT IP solves.

It is CASI's plan to license its technology to other industries that can apply its technology. Among there are industrial non-destructive testing (industrial CT), meteorology, metrology, histopathology imaging, entertainment industry animation, medical illustration, commercial computer graphics for advertising, virtual reality, air traffic control, multimedia, medical education and training, simulation, topography, mapping, surveying, (not topology) fluid mechanics and dynamics modeling and visualization, hyperspectral scanner imaging, and Earth Imaging Systems (for interpreting satellite imagery).

CASI leads with new ideas that will solve hard multiple industry wide problems. CASI is behind in implementation and building a customer base. CASI will catch up by a leapfrog strategy, taking the fruits of its research directly to the customer and end user.

The core technology intellectual property is protected by US patent #5,898,793 (Karron, Cox, and Mishra, 1999), and so advanced; that there is moderate risk of failing to achieve successful commercialization goals in time.

The benefits to the public are longer life, better quality of life, through improved medical care, at reduced cost through more effective delivery and utilization of medical imagery.

CASI's case for government use of taxpayer funds are based on the large benefits outlined previously. Benefits to the nation beyond those received by CASI are better citizen health and recovery from cancer; a major national health concern and cost. CASI's opportunities in the immediate future are the development of better cancer treatments within a price that third party payers reimburse.

Broader impacts in the more distant future are the scientific discoveries enabled by better and rapid segmentation of volumetric data, and better understanding of complex data relationships where computer graphics tends to obscure intricate objects. Applications include x-ray crystallography and proteomics, advanced computer graphics.

DMT research is pathbreaking because it enables a novel method of analysis for difficult problems in hyperspectral image understanding, x-ray crystallographic determination of molecular structure, and very large data set understanding. These applications are beyond the scope of CASI's immediate research plans, but CASI is anxious to support activities in these areas by business and scientific colleagues in these areas. CASI's development plans for DMT research permit any researchers to submit image stacks of any subject for online analysis. As the usefulness of the analysis becomes clear, the CASI ASP infrastructure can support multiple industries and technologies. For example, semiconductor epiaxial ultra lithography, or the deposition of nanoscale structures in semiconductor fabrication requires modeling of the crystal front growth. Isosurfaces and level set analysis is being used as an important modeling method for this industry. DMT analysis can be adapted for investigating and modeling seed crystal growth, and the role of perturbations and faults in the crystal lattice.

CASI's research opens many pathways to economic activity, many of which we can only dimly foresee at this point. DMT is a novel approach to computational geometry analysis from image data. DMT research is a career path for many young scientists in medical imaging and computational geometry; demonstration of the economic potential will attract entrepreneurial scientists to explore applications and launch new industries outside of academia.

CASI core technology will enable fast and cheap segmentation and registration of large datasets. CASI will exploit this technology for fast and low cost radiation treatment planning, over the Internet. The time required for billable studies will be reduced by hours for faster study throughput.

The main benefit is to patients, with less morbidity from cancer treatment, and better treatment throughput for treatment planners by physicians and medical physicists. Many hospitals and private practices will benefit, as they will not need to invest in expensive computers and software licenses to use CASI technology via its ASP web browser clients.

Isosurface modeling is an important method of data analysis in many physical science areas. Isosurfaces are of major benefit to meteorology, fluid and thermal dynamics, hydrodynamics, and solid-state physics. Isosurfaces are vital in x-ray diffraction studies to establish molecular structure for many biochemical applications, including proteomics. Traditionally, these are painstaking, long studies, where the two main bottlenecks are getting an unknown substance to crystallize, and the other is to fit a molecular backbone around the electron density isosurfaces. As CASI DMT provides an index of all of the objects in a density field, this will have important spillover benefits in the physical and basic medical sciences.

Synergy will be achieved with other computational geometry groups working in level set theory and advanced computational geometry research. CASI offers a cheap and accessible embodiment of Digital Morse Theory object mapping that will promote research in other groups that may not have the computing resources to model larger data sets, or money for expensive software packages. Surface modeling is complementary to volume imaging, which is the dominant visualization technology for computer graphics.

By developing DMT technology as an ASP, it will not require extensive technical abilities for others to run sample studies. Casual web surfers can also submit images or image stacks for sample analysis and modeling.

The PI and CASI have published its research findings in both the professional literature and via the CASI corporate web site at http://www.casi.net/. Publications range from Cox, Karron, and Mishra in 1993 to Karron and Cox, Karron, and Ferdous in 2001. Additional papers and presentations are underway for other national meetings such as Medicine Meets Virtual Reality 2002.

6 Need for ATP Funding

ATP Funding is needed because CASI's goal is to make a technical forward leap with the DMT based modeling and develop a business model to rapidly bring it to market. CASI needs the funding to focus on its core technology, and then the production of anatomic modeling for RT planning. Building on preliminary results with the NIH Visible Human Project (VHP), CASI will create new markets that will be profitable within five years.

Equity markets, in general, have a cloud of uncertainty over them at this time, which translates into investors staying on the sidelines. While we observe this somewhat in publicly traded equities, it is even truer of the illiquid private equity marketplace. Generally, the current requirements, among others, for private equity investors is that:

1. Profitability can be expected within two years.
2. The technology is reduced to practice.

CASI had made a significant effort to obtain private equity funding for this activity. A number of high net worth individual investors have been approached, as well as venture capital funds and corporations with bids to Toucan Capital Corp, Global Business Network, CMMC Ventures, Inc, Sumitomo Corporation of America, Madison Partners, Bristol Meyers Squibb, Paramount Capital and the Herrick Fund. CASI's proposal was uniformly rejected mainly for the reasons cited above.

Other potential sources of funding, which are not appropriate as follows:

1. NIH clinical funding is appropriate for funding specific disease applications, but not for funding the basic core modeling technology. NIH Funding will be pursued with our clinical collaborators in this project.
2. NSF funds universities. The pursuit of widespread academic acceptance is slow, and will not solve critical medical and industrial problems. NSF SBIR grants are inadequate and too short

term.

3. Medical and other imaging companies have stake in their own products and may fund research in their specific imaging technology. CASI's experience with imaging hardware companies is that they tend to restrict the research, with unacceptable intellectual property, publication, and marketing demands. Previous corporate sponsors of this research (SGI) pulled the plug with market downturns and when individual sponsors within the corporate structure leave, so does their support.
4. DoD SBIR Funding is too small and short term, with a heavy reporting burden. CASI has experience with staccato 6-month Phase I; halt, 18-month Phase II efforts. This is a suitable mechanism for applied development efforts of more mature technology, but not for the sustained fundamental research proposed here.

6.1 The ATP difference

No one industry or medical superspeciality has the patience and broad view to fund this effort for the general utility. Segmentation and registration issues impede progress in many disparate medical and scientific fields.

ATP can support the technical innovation and business risk of developing DMT technology into an infrastructural network resource for everyone on the Internet. This has too long of a ROI, and is too broad in its ultimate utility for private investors. ATP sponsorship will enable CASI to implement DMT algorithms for everyone on the net instead of proving them on paper for other mathematicians. DMT grew to solve the PI's painful problems doing image analysis projects for anatomic modeling. Anyone doing these studies can appreciate the utility and need for this proposed resource. CASI could win many more contracts if the facilities proposed here, were already in production. Clients feel ignored because CASI is focusing on research instead of directly applying itself to the clients' immediate problems with conventional hand editing solutions. CASI prefers not to give up the intellectual property rights. This broad risk weighed against broad national benefit requires a funding agency with a broad view and willingness to take a patient return on investment.

People are dying from treatment failures. Better treatment planning and evaluation will avert these deaths. Academic, industrial then commercial diffusion is too slow and ponderous; CASI will bring the fruits of its research directly and immediately to its clinical collaborators; and then to the medical and scientific public at large via its rapid ASP development plan. Working in parallel with commercial franchise implementers will further speed up the diffusion of CASI technology from a Brownian motion to a directed explosion.

6.2 ATP acceleration of the technology development

ATP's sponsorship provides not only acceleration in the rate of DMT computational geometry research, but a qualitative difference in the way this academic research is perceived. Demonstrating the economic value of this deep mathematical insight will stimulate more research to be developed by mathematically oriented scientists into economically and nationally beneficial projects.

The European Union (EU) has traditionally respected advanced mathematical concepts, as evidenced by EU investments in computer vision and graphics research. American technology development has tended to focus more on expensive hardware, and possibly neglected the benefits that a deeper understanding can bring (cheaper hardware, less overbuilt systems, better precision and accuracy).

If ATP declines to fund this project, the DMT research will limp along as a sideline to CASI image contracting and the PI's student dissertations.

Without ATP funding CASI will become a contract programming shop, hindered by its unimplemented ideas. Meanwhile the EU will move first into advanced image understanding on a theoretical level. Buggy academic software packages will follow from graduate students. New

modeling technology will appear first in Siemens medical imaging equipment, and then GE will license it. Eventually the state of the art in computational geometry will catch up to DMT. Research implementations could start appearing in 6 years, and software-containing DMT inspired package features appearing in 8 to 10 years.

CASI's goal is to leapfrog this slow, wasteful, and ponderous mechanism of incremental and diffusive scientific advancement.

6.3 CASI angel and VC private funding efforts

Mr. E. Gurfein, an early technology participant, with long experience in early technology development, was attracted to CASI. .Mr. Gurfein cannot raise private equity funding at this stage, yet he is willing to invest significant personal effort managing this project with the intent of raising private capital as CASI risk decreases sufficiently for private investment.

This research is in danger of failure caused by under-funding. CASI cannot do production contract programming and push the state of the art without adequate funding for research as well as production coders, product support, and business/marketing people.

7 Pathway to Economic Benefits: CASI commercialization strategy

CASI prospective customers are in two broad classes: Primary customers deal directly with the CASI ASP in the RT markets, while secondary customers deal with franchisors, who resell and package the CASI ASP server under their own label.

Primary customers include radiological image producers, medical imaging practices, and image consumers. They will use the CASI web services for better communication and distribution of their product with their client physicians. The technology will enable RT collaborative planning (studies with multiple drafters) at academic medical physics departments, as well as at physicians' homes, on the road, and at primary care community hospitals (which generally don't have the most sophisticated resources).

Secondary customers are customers attracted by franchisors' and CASI marketing activities for secondary application area. Example include cosmetic plastic surgeons planning craniofacial cases, implant oral surgeons planning a full mouth implant procedure, as well as computer graphics firms. Patents will demand it of their surgeons, particularly if the patients currently of patients as informed consumers, shopping for doctors. Patents increasingly want to know precisely what their surgeon will do to and for them. An emerging class of medical imaging applications is vanity radiology and imaging, particularly if the images are animated, colorful, engaging, and fun and easy to explore. Patients are doing full body scans at their own expense without any motivating clinical reason, looking for pre-clinical or subclinical problems, as part of the trend to comprehensive and expensive wellness medicine (Tuller 2001).

7.1 CASI technology development through bellwether early adopters and implementer-franchisers

Bellwether early adopters are a special class of clinical and scientific professionals who are the first to recognize and try to use early stage technology. These are technically sophisticated users willing to pay a high price for new technology and can manage to use it despite the bugs and problems. Their motivation is not profit. They are generally employed at academic medical centers and are highly respected by their peers and colleagues. Their recommendation for a new technology can catapult it into the broader market of less sophisticated users. The PI knows a number of these professionals in dentistry, endoscopic surgery, ENT, plastic surgery, craniofacial surgery, oral surgery, neurosurgery, ophthalmic, retinal, histopathology, obstetric surgery, orthopedic surgery, among others. CASI will collaborate by assisting these users in the development of CASI core technology in their specialty.

CASI will foster the business development of its technology in other application areas by working with franchisors. These are profit oriented software developers who see the utility of CASI technology in a problem area they have expertise in, and have the sophistication to write front-end browsers that address specific problems of the application area. They can be affiliated with bellwether early adopters. CASI will host private label web sites that have a special look and field given to it by its implementation franchiser. CASI will support potential implementer-franchisors by the development sample applications to stoke and demonstrate demand. Franchise fees will help fund for implementation costs. Each use of the CASI modeling technology will result in a charge to the account holder, and a credit to the franchiser. CASI technology is not specifically licensed, but leased to a franchise holder. CASI manages the back end image decomposition and segmentation, as well as billing and royalty collection. An example potential franchisor and end user is the Anatomic Travelogue (http://www.anatomicaltravel.com/), a neighboring NYC medical computer animation house.

CASI will take the major role in introducing the technology to marketplace through the CASI web site, professional marketing, communications, and commercialization activities. These consist of publication of papers in archival journals, conference presentations, and software demonstration at booths rented at major meetings. The CASI web site will provide free samples of the technology as the research emerges and becomes a working application. See the table below for representative professional outlets that the PI has presented at, is invited to present at, is publishing at, and will publish in. CASI understands the market from many perspectives, from surgical virtual reality, surgical simulation to functional neuromagnetic modeling and medical illustration/animation. The PI has observed the nature of the medical image market as a fragmented industry, with many independent minded clinical academic researchers with little cross specialty communication.

7.2 Professional Marketing Venues and Outlets

Archival Journals	**Date**	**Action**
Journal Of Mathematical Imaging and Vision	Fall 2001	Paper submitted and accepted
Graphical Models and Image Processing	Fall 2001	Paper submitted and provisionally accepted
Professional Society Meetings		
Society of Industrial and Applied Math Activity Group on Imaging Science: Imaging Science 2001 meeting	Oct 2001	Member. Invited Presentation
American Association of Physicists in Medicine 2001 Annual Meeting	July 2002,3,4	Member Presentation planned
Association for Computing Machinery (ACM) Special Interest Group on Graphics (SIGGRAPH)	Aug 2002,3,4	Member Submission, booth Planned
American College of Radiation Oncology	July 2002	Targeted society, submission planned
American Brachytherapy Society	June 2001	Targeted society, submission planned
Medical Conferences		
Medicine Meets Virtual Reality 2002	Jan 2002,3,4	Abstract submitted for presentation Booth for demos
IEEE Workshop on Scale-Space and Morphology in Computer Vision Scale-Space'02	July 2002	Senior Member Submission planned
IEEE Workshop Variational and Level Set Methods in Computer Vision	July 2002	

CASI submitted abstracts and made provisional reservations for a booth at Medicine Meets Virtual Reality 2002. CASI has standing invitations to publish in major mathematical computational geometry journals, and invitations for various specialty meetings. CASI will also publish and sponsor publication in the clinical literature, specifically in the Radiation and Oncology literature, the Neurosurgical literature, and present at various national meetings with its clinical collaborators. Bellwether academic collaborators are particularly eager for the publication opportunities CASI

presents. CASI expects to present at 12 major meetings a year by the third year of the project as PI and as collaborator.

7.3 Strength, Weaknesses, Opportunities, Competitiveness

CASI strength is its strong theoretical rubric (a broad setting bigger than just the algorithm being commercialized here) that can tie together many disparate schools of imaging science. DMT is becoming a popular idea, and students are seeking the PI as a dissertation research advisor.

CASI's weakness is the lack of widely available computer demonstrations. Currently, CASI software runs only on high-end SGI graphics workstations. This will be changed with ATP support, so that DMT analysis can be obtained from any web browser client, with the hard pixel crunching occurring on a much larger and capable server host.

CASI opportunities from a competitive standpoint are strong; there are no web based medical image to 3D modeling services in operating, or under development in the near term

CASI has no direct competition to its core technology of the indexing and segmentation of large image datasets via thin web clients in an ASP environment as of now.

The international markets on the Internet do not respect national boundaries, only cultural, intellectual, and language barriers. There is better acceptance and understanding for computational mathematics in the EU, as The PI's first isosurface papers were published in France. International diffusion will be faster in the EU as the main locations for basic R & D in medical imaging are European. This is evidenced by the sponsorship by the French Government Research Consortia INRIA and the Siemens Corporate Research and Development organization of two important research conferences in the closest related areas. These are the IEEE Workshop Variational and Level Set Methods in Computer Vision at the University of British Columbia, and Scale-Space'01: IEEE Workshop on Scale-Space and Morphology in Computer Vision in 2001, and the annual Eurographics conference

7.4 CASI plan for bringing initial application to market

CASI technology's primary application is RT planning. CASI will develop an ASP for its DMT modeling technology, and develop specialized web based front ends for RT with its clinical collaborators at NYUMC Radiation Physics. As the technology matures, users (or their patients) will begin to pay for connect hours and pixels/vertices processed, with the average case billing from $100 to $500; taking approximately 10 to 90 minutes. Physician users will keep saved cases on the server, and be able to allow patients to log in and see exactly what the clinician is proposing for the patient. This will help sell the case to the patient, and to third party payers. Additionally, records of the patient (patient electronic camera images, intraoperative photographs, patient video and audio) can be stored and fused with the radiological information to provide a comprehensive electronic patient multimedia record.

CASI's direct customers are breast cancer and prostate cancer patients, and their insurers. End users are the patients physicians, medical physicists and oncologists doing patients cancer cases. Patients, insurance companies, and other third party payers will be directly charged for CASI and / or study fees directly over the Internet B2B technology with on-line credit card charges or deposit accounts.

There are other competing image processing, virtual reality, and RT packages, as discussed above. These packages have a high capital cost, and require significant computers. None are available as ASP services due to current technology limitations in image compression and network bandwidth and latency. Established users of these packages will be attracted by CASI technology by free sample studies with their data. CASI will package its technology using emulation "skins", even emulating the features that CASI obsoletes so that users of competing packages get what they want, expect, and think they need.

CASI has an ambitious, but robust research plan. The most significant research risk is the failure to achieve acceptable interactivity for image segmentation and model manipulation over slower Internet connections of the expected of many small physician users. CASI expects that faster and cheaper Internet bandwidth will become ubiquitous, and reduce the project dependence on extreme data compression that is characteristic of most web based multimedia software. Should it become necessary, CASI will market a version of its software to run on Linux workstations with graphics accelerator cards, with traditional software licensing. Some customers may insist of this model of software as product, not service.

The next level of research risk is computational loading of the CASI server with image indexing and modeling code that bogs down the system and creates unacceptable user performance. Users who submit very large image stacks may cause problems for all users on a shared server. Significant work will be invested in optimizing the code to run in a high-level server computer environment with maximal efficiency. By the third year of this project CASI will have experience with issues of alpha tester computational loading to be able to estimate the costs of scaling the server to meet user demand growth projections. The worst case is that CASI will have to utilize supercomputers instead of server computers

Many commercially successful medical, animation, and image processing software packages do not push the state-of-the-art. Successful software packages are mainly customer driven, not research / technology driven. Software is a service industry. As long as CASI customers obtain a superior service, even before the core technology development is completed, the company can produce a useful and profitable product. CASI will have responsive and productive programmers building software for our alpha customers. CASI will build demonstrations that convince prospective clients that DMT is the way to solve their problem. It will take three years to do this. ATP funding is required to build the software services that will solve customer problems before they realize that they need it, and convince them that they cannot live without it. However, should there be problems with the PI's technology development, CASI programmers can fall back to what more conventional technology customers expect, and in the absolute worst case, produce a useful and profitable program without full utilization of DMT based modeling or ASP functionality.

CASI intellectual property protection is by PI's key US Patent #5,898,793, issued in 1999 under the old patent rules, so that the term of the patent is valid for the next 15 years. CASI technology is an ASP, and since the algorithms run on a CASI server, the algorithm is protected because it never leaves the company premises.

8 People and Organizations: Experience, Qualifications and CASI Commitment

CASI facilities and equipment consist of fully networked office space for three full time programmers, three SGI indigo2 extreme graphics super-workstations, three client PCs, a NT4 fileserver, and a Power PC PowerMac. The CASI computing and network environment is superior to many academic and medical departments, due to the PI's experience as system administrator for computer operations in various medical departments. The PI has been running the www.casi.net website for five years and it is a well-known and indexed Internet resource. The website attracts consulting clients, contract work, as well as medical and doctoral students. The site hosts the PI's academic BioInformatics graduate class web site. CASI administrative resources include online payroll processing, record keeping, accounting, and budget management and fiscal reporting. The PI has experience with the FAR and DFAR.

Subcontractors CISDD provide access to CUNY faculty, and collaborators at New York University Medical Center will provide clinical facilities, Medical Physics and clinical expertise, and medical imaging data and equipment.

The PI has entrepreneurial experience ranging from building a trucking company to East

Village NYC real estate (RE) renovation and development, all while in college. The RE financed the PI's pre-medical academic bid for medical school; that led to a job in the plastic surgery department at NYUMC. The PI also has extensive 'intrapeneurial' experience, promoting early computer networking technology within medical school in the early 80's. This is the ability to promote and launch projects inside large organizations. After earning a PhD at NYU Applied Science in Biomedical Engineering in 1993 and serving as a medical school research professor, the PI won the first of three DARPA SBIR grants and launched CASI in 1995. The PI's father was an entrepreneur, with a family manufacturing business reaching back two generations.

Mr. E. Gurfein is President and Principal of Meridian Resources and Development, Ltd in Englewood, NJ, which provides consulting and equity financing for companies and projects. He was previously with Philipp Brothers, Inc., (now Salomon Brothers), New York as Vice President for projects, performing analysis, negotiations, and financing of major international and domestic infrastructure projects involving mines, petrochemicals, metal processing, oil and gas pipelines, and power generation. He has served as Project Finance Manager for pipeline construction projects in Bolivia and Argentina from 1969 to 1972. He was a member of the Board of Directors of The Mates Fund, a mutual fund in New York from 1969 to 1974. He served as Programs Manager-Defense Department and NASA projects for Perkin-Elmer Corporation. His principal marketing responsibility was for the Hubble Telescope, among other space projects. Mr. Gurfein earned a BS at The City College of New York, a Diploma at the Industrial College of the Armed Forces, and an MBA at The University of Connecticut. Mr. Gurfein was a Captain in the US Army Ordnance Corps, serving as a ballistic missile R&D officer. Publications include "Infrastructure Project Finance" (1997) by the United Nations Department of Economic and Social Affairs, Interregional Workshop on Developing Project Financing, Bangkok.

Dr. G. Wolberg earned a BE and ME (EE) at the Cooper Union in 1985 and a PhD in Computer Science at Columbia University in 1990. He wrote "Digital Image Warping" in 1990 and the following year he was awarded a NSF Presidential Young Investigator Award.

Name	Affiliation	Effort	Project Responsibility	Relevant Experience and Expertise
Core Members	CASI PI, CCNY	100%	Will write DMT core code on server, market technology	PI, DMT inventor, C++, computational geometry, computer graphics, algorithm development.
D B Karron, PhD				
G Wolberg, PhD	CUNY, CASI	75%	Server DMT image matching code	Programmer. C++ programmer, algorithm development, digital image warping expert
Prof J L. Cox, PhD	CCNY	10%	Algorithm Development	DMT co-inventor, analysis of algorithms.
Mr. E Gurfein, MBA	Meridian Resource and Development, Ltd	75 %	Project Management and fundraising.	VC fundrasing for biotech, medical device, and chemistry startups; engineering venture capital
Consulting Members	CCNY	10%	Algorithm Development Braided DMT for Trajectory Planning	Encryption, Braid Theory, Computational Geometry
Prof M Anshel, PhD				
Prof G Herman, PhD	CCNY	10%	Algorithm Development	Theory of surfaces, image segmentation, digital topology
Prof F Bookstein, PhD	University of Michigan	10%	Algorithm Validation	Morphometrics, medical imaging and applied math
Clinical Participants	NYUMC Radiation Oncology	5%	Clinical Evaluation and Alpha testing	Breast cancer warrior using radiation therapy beams.
Chair S. Formenti, MD PhD				
Prof J K Dewyngaert, PhD	NYUMC Radiation Oncology	10%	Clinical application development	Radiation physicist; Specialist in prostate cancer research using radiation and brachytherapy
Prof Col (Ret) R A Satava, MD	Yale University Medical Center Dept. of Surgery	5%	Clinical application development	Endoscopic and Virtual Reality in Medicine pioneer
Professor L. Liebis, PhD	NYU MC	5%	Clinical evaluation	Instrumentation specialist. Statistical epidemiology.
Chair R. Bucholz MD.	St. Louis University Med Ctr. Dept of Neurosurgery	5%	Clinical Product Development	Neurosurgeon and medical technology entrepreneur Steriotactic neurosurgery system inventor
MD and or PhD graduate students	CUNY Graduate Center		Recruited as required	Java programmer. System administrator. Web site

Name	Affiliation	Effort	Project Responsibility	Relevant Experience and Expertise
To be named; three total	New England College of Medicine			designer and user interface tester, Medical Clinical Liaison

Notes on Above: Dr. Wolberg will devote part time effort to this project in the first year, increasing to full time in the second and third year, depending on the demands of the NAVY SBIR for which he is PI and will be an employee. Mr. Gurfein will devote more than half time professional effort to this project, increasing to full time in year three (not indicated in original budget). Drs. Herman, Cox, and Anshel will be funded through the CISDD subcontractor since they are full time CUNY tenured faculty working summer and part time during the academic year involvement is subject to release from teaching load by their respective departments. Non-tenured faculty are not subject to this requirement. Dr. Bookstein and Dr. Satava will be employed as a private consultant at the rate of 100$/hour for a maximum of $2000/Y, subject to change in project year maximum. Clinical Collaborators Drs. Formenti, Liebis, Dewyngaert, and Bucholz are not going to be compensated in the first year because CASI will be focusing on researching its core modeling technology, not clinical applications. CASI will be participating in obtaining NIH clinical funding that will pay for CASI clinical development and NYUMC research in alpha product development and professional commercialization. This is subject to change in the second and third project year depending on the availability of NIH funding.

9 Brief CASI history and performance

CASI incorporated in 1995, and is less than 10 years old. CASI formed while the PI was a research professor of surgery in cardiothorascic surgery at NYUMC. The PI won a DARPA Phase I SBIR (100K). The PI left NYUMC to devote full professional effort to the DARPA project. Subsequently, CASI won various small consulting subcontracts, a Phase II SBIR (650K$), Phase III (100K$), and a contract to explore Digital Morse Theory also at DARPA. The PI is President and CTO. CASI is a NY class C Corporation. The PI owns 100% of CASI, which is a small business.

Sponsored by Col (Ret) R. Satava, MD at DARPA, Tactical Audio Displays (TAD) helped launch CASI, which developed surgical navigation technology using computer music and 3D spatial sonification, enabling surgeons to navigate instruments inside the body without looking at or through a visual display. A US Patent was obtained (Wegner and Karron. 2000). The PI's effort to build or find a market for this technology has not yet achieved success. Adopters have been other university professors (E. Jovanov and M. Quinn). DNA and Protein sequence sonification was another effort to apply computer music and sonification technology.

Significant Federal R&D awards within the past five years in the same general technical area indicating feasibility of technical claims

Agency	Year	Description of the work	Accomplishments	PI	PM
DARPA	1998 - 1999	Digital Morse Theory Exploratory Studies	Rapid 2D contouring, Critical Point Identification, DMT Karron/Cox/Ferdous Dissertation and Paper	DBK	D. Healy, DARPA ACMP **dhealy@darpa.mil**
NIH VHP / U of Michigan	2000 - 2001	Segmentation for medical education content development	3D Color contouring, rapid segmentation; Karron 2001 presentation	DBK	D. Jenkins NIH **jenkins@nlm.nih.gov** T. Yoo, NIH, **yoo@nlm.nih.gov** B. Athey, U Mich **bleu@umich.edu**

CASI is submitting a NAVY Phase I SBIR for "Omnidirectional surveillance of carrier flight deck activity". The proposal eliminates camera operators and TV cameras that record aircraft takeoff and recovery operations with omnidirectional video systems. The geometric distortion is corrected using computer image warping and fused using DMT technology. The PI on this project is Dr. G. Wolberg

9.1 Financial and Employment Information

Income Statement	1998	1999	2000
Revenue	250,000	100,000	32,000

Cost of Sales			
R & D Expenditures	250,000	100,000	60,000
Net Income before Taxes	0	0	0
Net Income	0	0	0
Balance Sheet			
Total Assets	100,000	200,000	200,000
Total Liabilities	65,000	40,000	20,000
Net Worth (Owners Equity)	45,000	160,000	180,000
Employment Information			
Full Time Employees	2	1	1
Part time Employees/Contractors	3	1	2
Full time R & D Personnel	2	1	1
Part time R & D Personnel	1	0	0

Fiscal and Employment Table Notes: The CASI TAD project was funded for approximately $850K in DARPA SBIR Phase I, II and III from 1996 through 1999, the bulk of which was used in 1997 and not show on this table. The company entered the technology development 'valley of death', where basic R & D funding ends and commercial funding picks up the research. The PI has decided not to further pursue TAD commercialization, and is negotiating with colleagues interested in picking up academic funding with the CASI prototype equipment. The crash in CASI income in 2000 was due to two disastrous military and academic subcontracts

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